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Marasmioid and gymnopoid fungi of the Republic of Korea. 1. Three interesting species of *Crinipellis* (*Basidiomycota, Marasmiaceae*)

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Abstract — Two new *Crinipellis* taxa (*Basidiomycota, Marasmiaceae*) collected in the Republic of Korea, *C. rhizomaticola* and *C. nigricaulis* var. *macrospora*, are described. A third species, *Crinipellis zonata*, is recorded for the first time in this country. Their macro- and microscopic descriptions and molecular characteristics are also given. ITS regions of rDNA were studied in all collections. The combination, *C. trichialis,* is validated.

Key words — euagarics, taxonomy, phylogeny

Introduction

During field excursions to various localities in the Republic of Korea (South Korea) in 2007 and 2008, the authors collected rich material of marasmioid and gymnopoid fungi. During these excursions three interesting *Crinipellis* species were found. After comparison with the literature, two are described here as a new species and a new variety, respectively, and the third, *Crinipellis zonata*, was recorded for the first time in the Republic of Korea. Previously only two species of *Crinipellis* — *C. cremoricolor* R.L. Schaffer & M.G. Weaver and *C. scabella* (Alb. & Schwein.) Murrill (as *C. stipitaria* (Fr.) Pat.) — had been recorded in the Republic of Korea (Kim 1991, Lee & Lee 1991, Park & Lee 1991). Besides a detailed morphological analysis, a phylogenetic analysis of ITS rDNA sequences was also conducted to investigate their relationship.

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Materials and methods

Macroscopic descriptions are based on fresh basidiocarps. Microscopic features are described from dried material mounted in KOH, Melzer's reagent, and Congo Red using an Olympus BX-50 light microscope with a magnification of 1000×. For basidiospores, the factors E (quotient of length and width in any one spore) and Q (mean of E-values) are used. For lamellae, L means the number of entire lamellae and l the number of lamellulae between each pair of entire lamellae. Authors of fungal names are cited according to the International Plant Names Index Authors website (http://www.ipni.org/ipni/authorsearchpage.do), and colour abbreviations follow Kornerup & Wanscher (1983). Herbarium specimens are preserved in the herbarium of the Moravian Museum, Dept. of Botany, Brno, Czech Republic (BRNM). The type specimen of *Crinipellis nigricaulis* Har. Takahashi was borrowed from the Natural History Museum and Institute, Chiba, Japan (CBM-FB), which granted permission to extract and sequence ITS rDNA for comparison purposes.

Genomic DNA was extracted from small (3–4 mm^3) tissue samples from five specimens (BRNM 712569, 712570, 712579, 712580, CBM-FB-24125) following procedures set forth by Lee & Taylor (1990). ITS1-F and ITS4-B primers (Gardes & Bruns 1993) were used to amplify the complete rDNA ITS region. Temperature cycling included denaturation (30 s at 94 °C), annealing (30 s at 56 °C), and extension (60 s at 72 °C). Thirty-five cycles were run with the first denaturation and last extension times extended to 2 and 5 min, respectively. Purified PCR products were directly sequenced on an ABI Prism TM 377 DNA automatic DNA Sequencer (Applied Biosystems, Foster City, CA, USA) using a BigDye™ cycle sequencing kit, version 3.1 (Applied Biosystems), and the ITS1-F and ITS4-B primers used for amplification.

Sequences were edited with the DNASTAR software, version 5.0.5 (DNAStar, Madison, WI, USA). Sequences were aligned using CLUSTAL_X (Thompson et al. 1997). Phylogenetic trees were obtained using the Bayesian (MCMC) and maximum parsimony (MP) methods. MCMC analysis was performed using MRBAYES, version 3.0b4 (Ronquist & Huelsenbeck 2003), which generated a Bayesian inference of the phylogeny, using Metropolis coupled Markov chain Monte Carlo analyses (Geyer 1991). The general time reversible (GTR) model was employed with gamma-distributed substitution rates. Markov chains were run for 10^6 generations, saving a tree every 100^{th} generation, with the first 1000 trees discarded as burn-in. MRBAYES was used to compute a 50 % majority rule consensus of the remaining trees to obtain estimates for group posterior probabilities (PPs). Branch lengths were computed as the mean values over the trees sampled. Result reproducibility was tested by repeating this analysis five times using with random trees and program default parameter values. MP analysis was performed in PAUP*, version 4b10 (Swofford 2002) using heuristic searches with ten random sequence additions and branch swapping by tree bisection-reconnection (TBR). Relative robustness of the individual branches was estimated by bootstrapping (BS), using 10,000 replicates.

Moniliophthora species sequences were added to our studies based on recent molecular studies (Aime & Phillips-Mora 2005) that imply a monophyletic clade distinct from *Crinipellis* comprising *Crinipellis perniciosa* (Stahel) Singer and anamorphic fungi parasitic on cocoa (*Theobroma cacao*) and now included in the genus *Moniliophthora*

H.C. Evans et al. Two *Chaetocalathus liliputianus* sequences were selected as an outgroup based on a study by Matheny et al. (2006).

Taxonomy

Crinipellis nigricaulis* var. *macrospora Antonín, R. Ryoo & H.D. Shin **var. nov.**

MycoBank MB 513106, NCBI accession numbers FJ573196, FJ573197 Fig. 1

A varietate typica basidiosporis magnis, 10–11.5 × 3.75–4.75(–5.0) µm et cheilo-cystidiis brevis, 13–17(–20) × 4.5–6.0(–7.0) µm, differt.

Holotypus: Republic of Korea, Chuncheon, Dongsan-myeon, Bongmyeong-ri, 22.VII.2007, leg. V. Antonín 07.96 et R. Ryoo (holotypus in herbario BRNM 712569 preservatur).

Basidiocarps single. Pileus 1.5–5 mm broad, convex with a distinct, obtuse to almost applanate umbo with central papilla and abrupt and inflexed margin, later papilla less distinct and margin not inflexed, entirely radially adpressed fibrillose-hairy with ± smooth centre when young, later hairs disappearing from margin, remaining only around centre in older basidiocarps, entirely brown to dark brown (6E4 to 7E5–6) when young, then dark brown only at centre and around it, whitish towards margin; older specimens slightly striate-sulcate up to ¾ with slightly crenulate margin. Lamellae moderately close, L = 16–20, l = (0–)1(–2), emarginate and with small tooth, well-developed, pale cream with concolorous pubescent edge. Stipe very long, 55–200 mm, filiform, insititious, entirely distinctly hairy, concolorous with lamellae at apex, through brown (7E4–5) to dark brown (7F4–5) towards base, entirely brown in old basidiocarps. Rhizomorphs present, slightly hairy, brown-black.

Basidiospores 8.5–11.5 × 3.75–4.75(–5.0) µm, average = 10.1 × 4.1 µm, E = 2.2–3.0, Q = 2.4–2.6, fusoid, thin- or slightly thick-walled, non-dextrinoid. Basidia not observed. Basidioles 10–23 × 2.5–8.0 µm, fusoid, clavate, cylindrical. Cheilocystidia in the form of broom cells of the Siccus-type, 12–20 × 4.0–7.0 µm, clavate, (sub)cylindrical, subfusoid, thin-walled, hyaline; projections up to 8(–10) × 2.0 µm, digitate, thin- to slightly thick-walled, obtuse to subacute. Pleurocystidia absent. Trama hyphae ± cylindrical, thin- to slightly thick-walled, hyaline, up to 10 µm wide. Pilei-pellis a cutis of ± cylindrical, thin- to slightly thick-walled, mostly incrusted, dextrinoid or non-dextrinoid, up to 12 µm wide hyphae. Pileus hairs cylindrical, thick-walled (walls up to 1.5 µm thick), obtuse, less frequently subacute to acute, septate, ± irregular at base, up to c. 650 × 9.0 µm, dextrinoid, with walls pale yellow-brown in H_2O and olivaceous in KOH. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, smooth, dextrinoid, up to 5.0 µm wide hyphae with olivaceous walls in KOH. Stipe hairs similar to pileus hairs, 30–400 × up to 8.0 µm, septate, thick-walled, mostly acute, less frequently obtuse, dextrinoid. Clamp connections present in all tissues.

Habitat — On leaves of *Quercus mongolica*, *Quercus* sp., *Betula platyphylla* var. *japonica* and *Juglans mandshurica*.

Localities — Republic of Korea, Chuncheon, Dongsan-myeon, Bongmyeong-ri, Experimental forest of Kangwon National University, 37° 46' 46" N, 127° 48' 59" E, alt. 212 m, 22 July 2007, leg. V. Antonín 07.96 and R. Ryoo (holotype, BRNM 712569). – Republic of Korea, Pyeongchang, Chungtaesan Resort Forest, 37° 31' 24.78" N, 128° 17' 22.58" E, alt. 764 m, 17 July 2008, leg. R. Ryoo KG 231 (BRNM 712580).

Additionally revised specimens — *Crinipellis nigricaulis* var. *nigricaulis*: Japan, Kanawaga pref., Zushi-shi, 12 July 1996, leg. et det. H. Takahashi (CBM-FB 24125, paratype). – Japan, Kanawaga pref., Odawara-shi, 27 Sept. 1998, leg. et det. H. Takahashi (CBM-FB 24127, paratype).

Remarks — *Crinipellis nigricaulis* var. *macrospora* is characterised by a small, entirely brown to dark brown, then marginally whitish pileus, a very long filiform stipe, moderately large basidiospores, and cheilocystidia in the form of broom cells of the Siccus-type. Having olivaceous-coloured hairs in KOH, it belongs to sect. *Grisentinae* (Singer) Singer (Singer 1976, 1986).

The type variety of *C. nigricaulis* (Takahashi 2000) differs by basidiospores with different E and Q factors (8.0–11 × 4.5–6.0 µm, E = 1.6–2.2, Q = 1.8–1.9) and broader cheilocystidia (15–23 × 6–11 µm). Other characters and habit agree with our collection (CBM-FB 24125 and 24127, paratypes!). It is known only from Japan.

Crinipellis actinophora (Berk. & Broome) Singer differs by its habit (see drawings by Pegler 1986), a blackish brown pileus centre and smaller basidiospores (7–9.7 × 3.4–4.7 µm). According to a description by Corner (1996, as *C.* cf. *actinophora*), it has a larger pileus (8–12 mm), a much shorter stipe (8–15 × 0.5 mm) and smaller basidiospores (7.5–9 × 4–4.5 µm); however he does not mention the presence of cheilocystidia and their form. *Crinipellis alcalivirens* Singer has a larger, 6–12 mm broad, rusty to chestnut-brown pileus, a shorter stipe (12–14 × 0.6–0.8 mm), shorter and broader basidiospores (7.5–8.5 × 4.5–5.7 µm), different cheilocystidia not in the form of broom cells and possesses pleurocystidia. *Crinipellis trichialis* (Lév.) Pat. ex Antonín, R. Ryoo & H.D. Shin, **comb. nov.** MycoBank MB513425 [Basionym: *Agaricus trichialis* Lév., Ann. Sci. Nat., Bot. 3e Sér., 5: 113. 1846.] has a distinctly shorter stipe (3–9 × 0.3–1 mm), shorter and broader basidiospores (7.3–9.7(–10.2) × 4–6.7 µm), different cheilocystidia not in the form of broom cells, and possesses pleurocystidia; moreover, both of them grow on dead parts of monocotyledons (Singer 1976). Among species occurring on dicotyledons, *C. sapindacearum* Singer especially differs by a distinctly shorter stipe (9–14 × 0.4–0.5 mm), smaller basidiospores (7.5–8.2 × 3–6.5 µm), and present pleurocystidia. *Crinipellis tucumanensis* Singer also differs by a shorter stipe (13–36 × 0.3–1 mm), smaller basidiospores (5.5–8.5 × 4–6 µm), and present pleurocystidia, and has differently shaped cheilocystidia (Singer 1976).

Crinipellis rhizomaticola Antonín, R. Ryoo & H.D. Shin **sp. nov.** Fig. 2

MycoBank MB 513107, NCBI accession number FJ573198

Pileo 12–22 mm lato, conico vel convexo-conico, papillato, centro obscuriore brunneo, marginem pallido. Lamellis cremeis. Stipite 40–60 × 0.75–1.25 mm, apicem pallide brunneo, ad basim obscuriore brunneo. Basidiosporis 8.5–10 × 4.0–5.0(–5.25) µm, fusiformibus-ellipsoideis, lacrimoideis, hyalinis, inamyloideis. Cheilo-cystidiis 17–32 × 4.0–7.0 µm, clavatis vel subcylindraceis, cum 1–3(–4) projec-tionibus apicularibus. Pleurocystidiis 34–42 × 7.5–9.5 µm, clavatis, tunicatis. Pilis pilei usque c. 700 × 3.0–7.0 µm, cylindraceis, crassitunicatis, dext-rinoideis, in KOH olivaceis. Hyphis fibulatis. Ad rhizomatibus putridis.

Holotypus: Republic of Korea, Jeju, insula Udo, 4.VII.2008, leg. V. Antonín 08.55 et R. Ryoo (holotypus in herbario BRNM 712570 preservatur).

Basidiocarps single. Pileus 12–22 mm broad, conical, then convex-conical, always with a small and sharp papilla at ± subapplanate centre, margin inflexed, then straight, centre always chestnut-brown (8E–F8) and tomentose, otherwise radially adpressed hairy on paler, pale yellow or pale orange (4–5A3) ground, hairs of the same colour as pileus centre; margin slightly (when young) to ± distinctly (when old) sulcate and crenulate. Lamellae moderately close, L = 19–25, l = 2–3, emarginate and attached with small tooth, well-developed, intervenose, pale cream with concolorous pubescent edge. Stipe 40–60 × 0.75–1.25 mm, cylindrical, slightly broadened at apex and at base, insititious, longitudinally striate, pale brownish at apex, through brown (7E7) to dark brown (7F7) towards base, entirely covered with hairs concolorous with pileus centre or slightly paler. Context membranaceous, without any special smell. Rhizomorphs absent.

Basidiospores 8.5–10 × 4.0–5.0(–5.25) µm, average = 9.3 × 4.6 µm, E = 1.8–2.2, Q = 2.0, fusoid-ellipsoid, lacrimoid, thin-walled, non-dextrinoid. Basidia e.g. 31 × 9.5 µm, 4-spored, clavate. Basidioles up to 35 × 3.0–10 µm, fusoid, clavate, cylindrical. Cheilocystidia 17–32 × 4.0–7.0 µm, clavate, subcylindrical, irregular or mostly with 1–3(–4) large projections at the top, thin- to rarely slightly thick-walled, hyaline. Pleurocystidia scattered, 34–42 × 7.5–9.5 µm, clavate, thin-walled, originating in subhymenium, with slightly refractive contents. Trama hyphae ± cylindrical, thin-walled, hyaline, non-dextrinoid, up to 8.0 µm wide. Pileipellis a cutis of radially arranged, cylindrical or inflated, thin- to slightly thick-walled, non-dextrinoid, up to 10 µm wide hyphae with (sub)hyaline to pale ochraceous walls in KOH. Pileus hairs cylindrical, thick-walled (walls up to 2.5 µm thick), acute or subacute, septate, at base curved or ± irregular, up to c. 700 × 3.0–7.0 µm, dextrinoid with walls yellow-brown in H_2O and olivaceous in KOH; mixed with short, fusoid, cylindrical, regular or irregular, ± weakly dextrinoid cells. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, smooth, dextrinoid, up to 5.0 µm wide hyphae with walls yellow-brown in H_2O and brightly olivaceous

in KOH. Stipe hairs similar to pileus hairs, c. 70–500 × up to 8.0 µm, obtuse to subacute, more or less (scattered) septate, thick-walled (walls up to 2.5 µm thick), with a non-obliterated lumen, dextrinoid, walls yellow-brown in H_2O and brightly olivaceous in KOH. Clamp connections present in all tissues.

Habitat — On rhizomes of a plant (*Petasites*?) in open woodland with *Pinus densiflora*.

Locality — Republic of Korea, Jeju, Udo Island, 33º 29' 34" N, 126º 57' 53" E, alt. 90 m, 4 July 2008, leg. V. Antonín 08.55 and R. Ryoo (holotype, BRNM 712570).

Remarks — *Crinipellis rhizomaticola* is characterised by a rather large, chestnut-brown pileus, moderately large basidiospores, clavate, subcylindrical cheilocystidia that are irregular or have 1–3(–4) large projections at apex, and well-developed pleurocystidia. Having olivaceous coloured hairs in KOH, it belongs to sect. *Grisentinae* (Singer 1976, 1986).

Among species with well-developed pleurocystidia, *Crinipellis alcalivirens* has a smaller, 6–12 mm broad, differently shaped pileus, a shorter stipe (12–14 × 0.6–0.8 mm), smaller basidiospores (7.5–8.5 × 4.5–5.7 µm), narrowly ventricose, subfusoid or ampullaceous pleurocystidia, and grows on monocotyledons. *Crinipellis trichialis*, also growing on monocotyledons, has a smaller, only 2–7 mm broad pileus, a distinctly shorter stipe (3–9 × 0.3–1 mm), and broader basidiospores (7.3–9.7(–10.2) × 4–6.7 µm). Among species growing on dicotyledons, *C. sapindacearum* has a smaller pileus (3–5 mm broad), shorter stipe (9–14 × 0.4–0.5 mm), smaller basidiospores (7.5–8.2 × 3–6.5 µm) and cheilocystidia in the form of broom cells, and *C. tucumanensis* a smaller, only 4–13 mm broad, fulvous brown pileus, a shorter stipe (13–36 × 0.3–1 mm) and smaller basidiospores (5.5–8.5 × 4–6 µm) (Singer 1976). The African species *Crinipellis pseudosplachnoides* (Henn.) Pat. differs especially by a smaller, 7–15 mm broad, pale brown pileus, a shorter stipe (10–40 × 1–2 mm), larger (42–65 × 5–6 µm), and cylindrical clavate pleurocystidia (Pegler 1977) and *C. glaucospora* (Beeli) Pegler by a reddish brown pileus, a shorter (10–25 × 1–1.5 mm), deep reddish brown stipe, smaller basidiospores (6–8.5 × 3.2–4 µm), differently shaped cheilocystidia, and shorter (21–24 × 4–5.5 µm), sinuous-fusoid, and mostly pointed pleurocystidia (Pegler 1966). *Crinipellis scabella* has smaller basidiocarps with paler, orange- to red-brown pileus hairs on paler cream white background, broader basidiospores ((6.5–)7.5–9.5(–10.5) × (4.0–)4.5–6.0(–8.0) µm), and differently shaped cheilocystidia (Antonín & Noordeloos 1997, 2009).

Crinipellis zonata (Peck) Pat. Fig. 3
NCBI accession number FJ588911

Basidiocarps single or in groups. Pileus 8–27 mm broad, conical or convex-conical with a distinctly to obtusely umbonate centre with central umbilicus

and inflexed margin when young, convex or applanate with papilla on distinct umbo and inflexed margin when old, entirely sparsely tomentose, with (yellowish) chestnut-brown zones when young, then dark brown. Lamellae well-developed, slightly crowded, L = 40–48, l = (0–)1, attached with small tooth, pale cream with concolorous edge. Stipe 30–56 × 1–2 mm, cylindrical, slightly broadened at base, insititious, entirely distinctly hairy, longitudinally striate, pale brownish at apex, through brown to dark brown towards base. Spore print white.

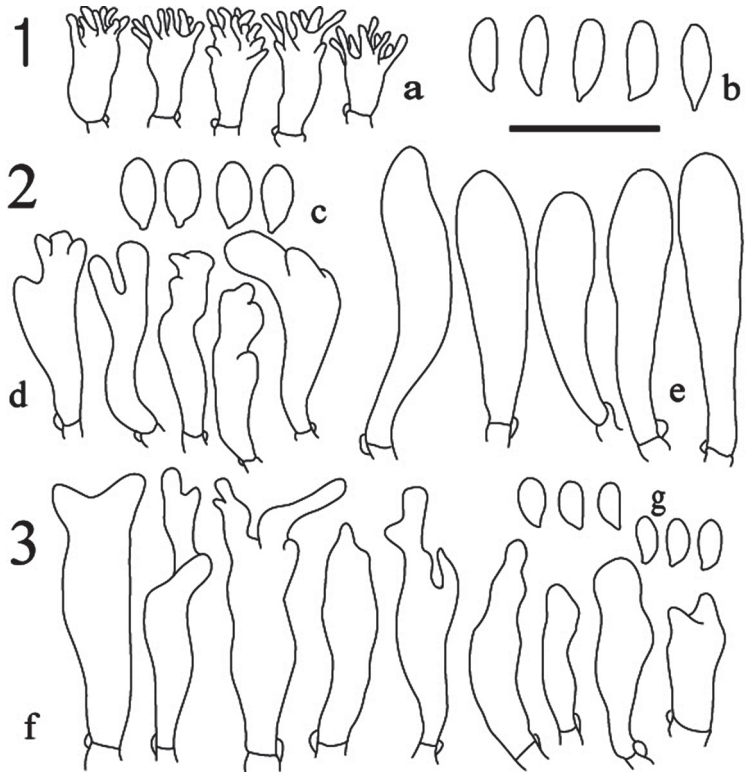
Basidiospores 6.5–7.25 × 3.0–4.0 μm, average = 6.8 × 3.5 μm, E = 1.5–2.3, Q = 2.0, (fusoid-)cylindrical-ellipsoid, thin- to slightly thick-walled, smooth, both dextrinoid and non-dextrinoid. Basidia 25–30 × 6.0–6.5 μm, 4-spored, clavate. Basidioles 15–28 × 3.0–8.0 μm, clavate, cylindrical or fusoid. Cheilocystidia 20–45 × 5.0–9.0 μm, cylindrical, clavate or fusoid, irregular, branched or subcoralloid, thin- to slightly thick-walled, non-dextrinoid. Pleurocystidia absent. Trama hyphae cylindrical to subinflated, thin- to slightly thick-walled, non-dextrinoid, up to 20 μm wide. Pileipellis a cutis of ± radially arranged, cylindrical to subinflated, ± slightly thick-walled, non-dextrinoid, smooth, up to 10(–15) μm wide hyphae. Pileus hairs c. 50–800 × 4.0–10 μm, cylindrical with irregular base, obtuse, septate, dextrinoid, with walls yellow-brown in H_2O and KOH; mixed with smaller, irregularly clavate, fusoid or cylindrical, less distinctly dextrinoid cells. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, non-dextrinoid, up to 4.0 μm wide hyphae. Stipe hairs similar to pileipellis hairs. Clamp connections present in all tissues.

Habitat — On twig of deciduous tree.

Locality — Republic of Korea, Hongcheon, Dong-myeon, Deokchi-ri, 37° 41' 57.84" N, 127° 57' 28.32" E, alt. 181 m, 28 Aug. 2008, leg. R. Ryoo KG 253 (BRNM 712579).

Remarks — *Crinipellis zonata* is characterised by having rather robust basidiocarps with a brown coloured pileus and stipe hairs, rather small basidiospores, well-developed cylindrical, clavate or subfusoid, irregular to apically branched cheilocystidia, and by the absence of pleurocystidia. It belongs to sect. *Crinipellis* (Singer 1976, 1986).

Our collection agrees well with the description of *C. zonata* by Redhead (1989), including the attachment of the stipe base. The only difference is in size and shape of the basidiospores, which are larger (4.8–8 × 3.8–5 μm) and broadly ellipsoid to subglobose in his description. However, Doyle (1987) described basidiospores as (5.8–)6.2–7.6(–8.5) × 3.6–4 μm. Basidiospores in our collections were often (fusoid-)ellipsoid but some of them were almost distinctly cylindrical-ellipsoid. However, this character falls within the variability of this taxon.



Figs. 1–3. Fig. 1. *Crinipellis nigricaulis* var. *macrospora*; a. cheilocystidia, b. basidiospores; Fig. 2. *Crinipellis rhizomaticola*; c. basidiospores, d. cheilocystidia, e. pleurocystidia; Fig. 3. *Crinipellis zonata*; f. cheilocystidia, g. basidiospores.
Scale bar = 20 μm

According to Redhead (1989), *Crinipellis cremoricolor* represents only a variety of *C. zonata* with a cream to cartridge buff pileus and a stipe and pale pinkish cinnamon lamellae, named *C. zonata* var. *cremoricolor* (R.L. Schaffer & M.G. Weaver) Redhead. *Crinipellis zonata* is only known from North America (Canada, USA; Doyle 1987, Redhead 1989) and Europe (Portugal; Antonín & Noordeloos 1997, 2009) to date.

Phylogenetic analysis

Based on ITS rDNA sequences obtained in this study and from GenBank, the phylogenetic placement and relationship of the three species of *Crinipellis*

collected in the Republic of Korea were inferred from MCMC and MP analyses. Eighteen sequences were aligned to create a dataset. For MCMC inference, all five analyses resulted in the same tree topology and almost identical PPs. The phylogenetic tree produced is shown in Fig. 4. Of the 639 total characters, 149 were parsimony-informative, and MP analysis produced 13 MP trees of 258 steps with a consistency index of 0.8682 and a retention index of 0.9272. Since no difference was found between the tree topologies from the two analyses, only a MCMC tree is shown.

The investigated sequences were divided into two distinct groups, A and B, which were strongly supported by high reproducibility values (MCMC PP/MP BS) of 1.00 / 100 % and 0.99 / 94 %, respectively. Clade A includes the sequences deposited as *Moniliophthora perniciosa, M. roreri, Crinipellis roreri* var. *roreri* (and var. *gileri*), and *C. brasiliensis*, whereas clade B includes those of *C. nigricaulis* (and

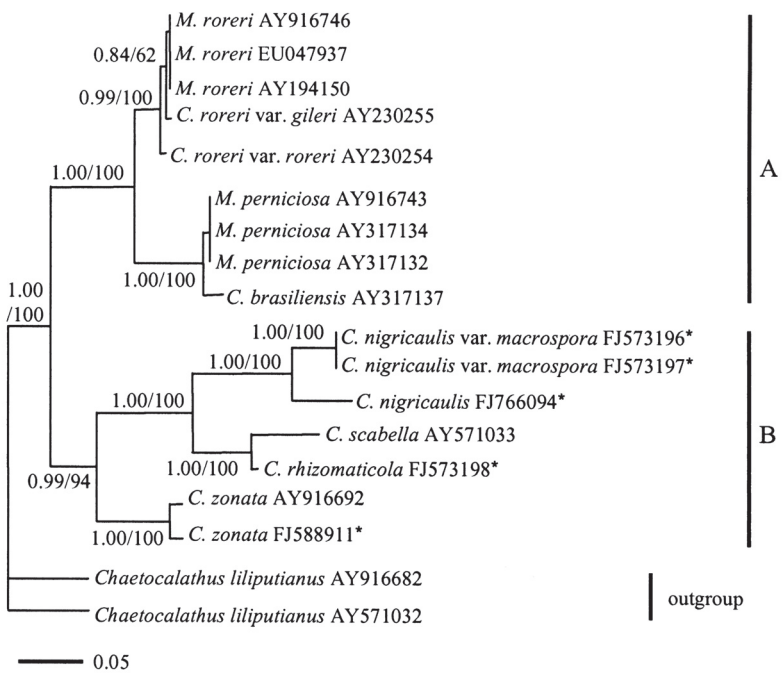


Fig. 4. Phylogenetic tree of *Crinipellis* sensu lato including *Moniliophthora* species based on the complete ITS rDNA region (ITS1, 5.8S rDNA, and ITS2), showing mean branch lengths of a 50 % majority-rule consensus tree from a MCMC analysis. MCMC PP / MP BS values are given above the supported node. The scale bar equals the number of nucleotide substitutions per site. An asterisk (*) denotes taxa sequenced in this study.

var. *macrospora*), *C. scabella*, *C. rhizomaticola,* and *C. zonata*. Clade B represents the genus *Crinipellis* as it includes the type species of the genus, *C. scabella*. In the ITS-based tree, the three Korean taxa — *Crinipellis nigricaulis* var. *macrospora*, *C. rhizomaticola, C. zonata* — form three distinct branches in clade B. The specimens of *C. nigricaulis* var. *macrospora* form a group with the type specimen of *C. nigricaulis*, but shows 29 base substitutions with the latter taxon, supporting the introduction of a new variety for the former. Although two sequences of *C. nigricaulis* and *C. nigricaulis* var. *macrospora* show a high nucleotide difference, they share many morphological characters and habit. They show minor differences in the sizes of basidiospore and cheilocystidia. The ITS sequences of *C. rhizomaticola* and *C. scabella* form a subgroup with high supporting values (1.00 / 100), but a sequence divergence of 3.4 % (22 out of 639 nucleotide characters were different) was found between them. Compared with a sequence (AY916692) of *C. zonata* retrieved from GenBank, the Korean material showed six base substitutions in ITS rDNA, but they clustered to a well-supported group (1.00 / 100).

Discussion

In the ITS-based analysis, the grouping of the members in clade A was similar to previous works indicating the close phylogenetic affinities of *Moniliophthora roreri* var. *roreri* and var. *gileri* (as *Crinipellis roreri* var. *roreri* and var. *gileri*) (Evans et al. 2003) as well as *C. brasiliensis* and *M. perniciosa* (as *C. perniciosa*) (Arruda et al. 2005). The clade B result also agreed well with the monophyletic *Crinipellis* clade indicated by Aime & Phillips-Mora (2005). The ITS phylogeny does not seems to be consistent with previous morphology-based sections of *Crinipellis*; *C. rhizomaticola* and *C. scabella,* placed respectively in sections *Grisentinae* and *Crinipellis* are phylogenetically closer than are *C. nigricaulis* var. *macrospora* (sec. *Grisentinae*) and *C. zonata* (sec. *Crinipellis*).

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